

**STRUCTURAL FIREFIGHTERS USE OF WILDLAND
PERSONAL PROTECTIVE CLOTHING AND EQUIPMENT
ON FLORIDA WILDFIRES**

EXECUTIVE LEADERSHIP

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ABSTRACT:

The use of structural personal protective clothing and equipment for wildland firefighting in Florida received considerable attention during the state's 1998 summer fire season. Over 5,000 firefighters were required to fight over 2,000 wildfires that burned 500,000 acres of wildland and urban-interface areas. Concerns raised over the use of structural personal protective clothing and equipment centered around the fact that this clothing and equipment contribute significantly to increased physiological stress and heat related injuries to the firefighter.

Evaluative and historical research were used to answer the following questions:

1. Are any structural fire departments in Florida providing wildland personal protective clothing and equipment to fire suppression personnel?
2. What are the reasons for not providing this equipment?
3. Are there any national standards for wildland personal protective clothing and equipment?

A review of published literature was conducted to gather information on the use of structural protective clothing on wildland fires. In addition, a survey of Florida fire chiefs was conducted to gather information regarding structural fire service use of wildland personal protective clothing and equipment.

The survey found that 54% of the participating departments were providing wildland personal protective clothing and equipment to their fire suppression personnel. Forty-six percent

of the departments responding to the survey stated that they did not provide this clothing and equipment.

Cost and frequency of wildland fires were the primary reasons for not providing wildland personal protective clothing and equipment.

Recommendations include purchasing wildland personal protective clothing and equipment for fire departments that respond to greater than twenty-five wildfires annually and having greater than fifty percent of their coverage area in wildland-urban interface. Departments issuing this equipment should provide full complements (including fire shelters) and have written standard operating procedures for its use.

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INTRODUCTION:

The potential for loss of structures and other improvements to private property from fire in Florida's wildland-urban interface has required structural fire services to become more involved in fire suppression work which traditionally has been performed by wildland fire agencies. In many cases, structural fire personnel are battling these fires while wearing personal protective equipment that is designed for structural fire suppression. Wearing this clothing and equipment for extended periods on wildland fires raises many concerns within the wildland and structural fire service communities.

Many of these concerns (and the basis for this research) were brought to a head during Florida's 1998 summer fire season when over 5,000 firefighters from across the country battled these fires. Many of these firefighters were from structural fire departments who came to Florida without wildland personal protective clothing and equipment. Efforts were made to supply this clothing and equipment to as many firefighters as possible, however, many were required to perform their duties wearing structural protective gear.

The problem is that the use of structural personal protective clothing and equipment for wildland fire suppression work increases the potential for physiological stress and heat related injuries to the firefighter.

The purpose of this research is to determine whether or not structural fire departments in Florida are providing wildland personal protective clothing and equipment to personnel who periodically engage in wildland firefighting.

This study uses evaluative and historical research and seeks to answer the following questions:

1. Are any structural fire departments in Florida providing wildland personal protective clothing and equipment to fire suppression personnel?
2. What are the reasons for not providing this equipment?
3. Are there any national standards for wildland personal protective clothing and equipment?

The primary method for conducting this research was surveying 63 Florida fire chiefs in order to gather data regarding the number of departments providing this clothing and equipment to their suppression personnel. The research also included a literature review of information describing the differences between wildland and structural personal protective clothing and equipment, the physiological effects of wearing structural clothing on wildland fires and existing national standards for personal protective clothing on wildland fires.

BACKGROUND AND SIGNIFICANCE:

The National Fire Academy's Executive Leadership Course requires that each student conduct an applied research project within six months of completing the class. The topic for this research is Structural Firefighters Use of Wildland Personal Protective Clothing and Equipment on Florida Wildfires.

The research is important to fire services in Florida for the following reasons:

1. It determines if there are any structural fire departments in Florida who are providing wildland personal protective clothing and equipment to fire suppression personnel?
2. It identifies reasons for not providing wildland personal protective clothing and equipment to structural firefighters.
3. It identifies national personal protective clothing and equipment standards for firefighters involved in wildland firefighting.

The research is related to Module 11, "Managing Change" of the Executive Leadership Course.

It is not currently known if structural fire departments in Florida are providing wildland personal protective clothing and equipment to structural firefighters who routinely engage in

wildland firefighting. Identifying departments that do provide this equipment may serve as a benchmark for other structural departments who are considering purchasing wildland personal protective clothing and equipment.

It is assumed by many that the primary reason for not providing this equipment to structural firefighters is lack of funding. However, the research may identify reasons that justify not providing this clothing and equipment by individual departments.

The research identifies national standards for wildland personal protective clothing and equipment and clarifies how these standards apply to the structural fire services.

LITERATURE REVIEW:

A review of existing literature found numerous published and non-published information regarding the use of proper, personal protective clothing and equipment while suppressing wildland fires. Additional published information was found regarding the disadvantages of wearing structural personal protective gear while suppressing wildland-urban interface fires. Information for this research was obtained from the Learning Resources Center at the National Emergency Training Center, the National Fire Protection Association and the U.S. Forest Service Missoula Technology & Development Center in Missoula, Montana.

Personal protective clothing and equipment used by structural fire services are designed to perform differently than that used by wildland firefighters (National Wildfire Coordinating Group [NWCG], 1990). It is important for both fire service groups to know these differences, to understand the limitations of each type of personal protective clothing and equipment and to realize that they are not interchangeable. Fire officers must insist that all personnel who engage in suppression activities wear the correct personal protective clothing and equipment for the environment in which they are working in (Mangan, 1997). Fire departments that provide both structural and wildland suppression services should establish guidelines for firefighters on which protective equipment to wear on a given incident (National Fire Protection Association [NFPA], 1997).

Structural personal protective clothing and equipment is designed to provide safe exposure to high levels of radiant heat and direct contact to flames for short durations; generally not to exceed 20-30 minutes (Mangan, 1996). This clothing has been proven to reduce the

number of burn injuries during these brief exposures to high intensity heat (Univ. of Calif at Davis, 1998). However, increased protection against intense radiant heat by heavier, thicker protective gear increases the probability of heat stress injuries when the structural firefighter becomes physically active for longer periods than those mentioned above (Personal communication, L. Anderson, January 26, 1999).

Wildland firefighters often work 12-16 hour shifts and may work 24 hours or longer during initial attack phases of large, wildland fires. This work is physically demanding and may take place with air temperatures in excess of 100 degrees Fahrenheit (Mangan, 1996). Firefighting in this environment requires that the firefighter balance the need for thermal protection from radiant heat with the need to release heat generated by the body which, if not allowed to escape, can lead to injuries resulting from heat stress. In other words, the goal of wildland personal protective clothing is to let heat out so that the body can cool itself (Budd, Brotherhood, Hendrie, Cheney and Dawson, 1996).

Winston (1997) suggests that not all structural fire departments responding to wildland fires need to purchase wildland personal protective clothing and equipment. Departments having smaller acreage of wildland-urban interface areas that are easily accessible and have fires that are easily suppressed do not need to provide this type of protective gear. He recommends, however, that departments who could and do respond to larger and more frequent fires provide wildland personal protective clothing and equipment.

The key ingredient to increasing physiological stress is increasing body temperature. The human body absorbs heat from the environment and produces heat through physical activity. The greater the activity, the greater the amount of heat generated and the more physiological stress

affects the body. The body releases this heat and/or stress through sweating which carries heat away from the body in vapor form. In cooling the firefighter it is necessary that the vaporized heat be carried away from the body as soon as possible. This is best achieved through ventilation and absorption of sweat by the firefighters clothing (Grilliot, M.I., 1989).

Budd, et al. (1996) noted that the total heat load on wildland firefighters is generated primarily through physical exertion rather than by the fire itself. Their research indicated that firefighters generate approximately 700 watts of energy with only 200 of these being generated by the fire through radiant heat. The remaining 500 watts is actually generated in the firefighters own muscles through physical exertion. Trapping this heat under layers of heavy, structural protective clothing can incapacitate the firefighter within thirty minutes.

In their study, Physiological Responses to Working in Bunker Gear, Bone, Clark, Smith and Petruzello, (1994) noted that firefighters experienced significantly greater cardiovascular stress while walking on motor driven tread mills for fifteen minutes while wearing standard NFPA bunker gear. Protective clothing worn in this research included bunker boots, bunker pants, turnout coats, Nomex hood and gloves. The study found that heart rate, rectal temperature, mean skin temperature and oxygen consumption were significantly higher than when the same firefighter performed the same task wearing station uniforms. Another significant finding was that wearing full bunker gear caused rectal temperatures to continue climbing during recovery time once the test was completed.

Similar research conducted in Australia which measured the thermal effects of structural personal protective clothing produced similar results. Firefighter body reactions were measured while stepping on and off a 30 centimeter stool at 12 steps per minute for sixty minutes while

wearing full turnout gear. Adverse effects to firefighters included restricted evaporation of sweat which reduced cooling, increased heat storage, cardiovascular strain, fatigue and failure to attain thermal equilibrium after sixty minutes of work. The research indicated that the use of bunker gear for prolonged, strenuous fire line work can result in cumulative heat stress, a risk of heat exhaustion and a need for more frequent rest periods for cooling off (International Journal of Wildland Fire 7(2) 207-218, 1997).

National standards for wildland personal protective clothing were approved in 1993 with the National Fire Protection Association's adoption of NFPA 1977, Standard on Protective Clothing and Equipment for Wildland Firefighting (NFPA 1998). The goal of NFPA 1977 was to provide thermal protection for the wildland firefighter using flame resistant clothing and equipment without causing excessive internal heat load (NFPA, 1998). NFPA approved wildland personal protective clothing is comprised of outer garments that include loose fitting, fire resistant Nomex shirts and pants, leather gloves and boots, hard hat and fire shelter (Mangan, 1993). Loose fitting clothing has been proven to be more important than the fire resistance of materials in preventing burn injuries (NFPA, 1998). This clothing and equipment must not contribute to fatigue, it must not fail prematurely, and it must be functional, durable, comfortable and economical.

Current Nomex clothing approved for wildland firefighting has proven to be durable and has proven to provide good thermal protection (Mangan, 1993). These garments are usually worn in a combination of fabric weights. Shirts are made of lighter 5.5 to 6.5 ounce fabric because the upper body produces most of the heat that must be released in order to protect the firefighter. Pants are made of 8 to 12 ounce material in order to protect the firefighter from

abrasion, punctures and tearing. Materials lighter than these reduces protection from radiant heat. Heavier materials impede body movement and reduce body cooling (NFPA, 1998).

Gloves for wildland firefighting should be made of chrome-tanned leather with narrow stitches that protect the firefighter from blisters, scratches cuts and burns (Mangan, 1993). They should be long enough so that a gap does not exist between the shirt sleeve and the glove and they should have a gauntlet attached that prevents fire brands from falling into the glove and burning the hand (Winston, 1997).

NFPA standards require that leather boots have a minimum height of eight inches and have skid resistant soles. Boots should provide firm ankle support since wildland firefighters are required to work in a wide range of terrains (NFPA, 1998). Steel toed boots are not recommended because they retain heat longer when subjected to intense radiant heat (Winston, 1997).

Structural firefighter helmets can be worn on wildland fires however; they are heavier than wildland hardhats and can be tiring when worn for long periods of time under strenuous working conditions (Winston, 1997). NFPA standards require helmets to weigh no more than 20 ounces and include an energy absorbing suspension system with sweat band, chin strap, nape device, goggle clips, and reflective markings (NFPA, 1998).

Goggles are considered a firefighting accessory and have no design or performance standards. However, goggles should not be made of materials that melt, drip or ignite at temperatures of less than 400 degrees Fahrenheit (NFPA, 1998). They should also be ventilated to minimize fogging and have impact resistant lenses (NWCG, 1990).

The fire shelter may be the most critical piece of personal protective equipment the

firefighter can have when suppressing wildland fires (Mangan, 1997). It's use is considered a last resort when faced with an entrapment situation where no other means of escape are possible. The shelter is a fiberglass-aluminum laminate pup tent that is designed to reflect radiant heat and trap cool air that helps protect the firefighters lungs and airways (USDA 1986). NFPA 1977 states that approved fire shelters must meet U.S. Forest Service specifications (NFPA 1998).

There is no current NFPA approved air-purifying respirator protection for wildland fire fighting (NFPA, 1997).

NFPA 1977 does not address the various types of undergarments that can be worn under personal protective clothing (NFPA1998). However, proper undergarments are effective at providing the firefighter with additional thermal protection and with assisting in absorption and transportation of perspiration away from the body. Thermal protection is provided by adding an additional layer of fabric and air between the radiant heat source and the skin. Knit fabrics are recommended because they generally will trap more air than woven fabrics. Adding this extra layer of protection can reduce firefighter burns by fifteen percent. Undergarments reduce heat stress to the firefighter by absorbing and transporting moisture away from the body in order to cool the firefighter during heavy physical work. Any undergarment used in wildland firefighting should resist melting when exposed to high levels of radiant heat (NFPA, 1998).

NFPA 1500, Fire Department Occupational Safety and Health Program (NFPA, 1997) states that "the fire department shall provide each member with the appropriate protective clothing and protective equipment to provide protection from the hazards to which the member is likely to be exposed. Such protective clothing and protective equipment shall be suitable for the tasks that the member is expected to perform" (p. 1500-13). In addition, NFPA 1500 states, "the

fire department shall establish standard operating procedures for the use of wildland protective clothing and equipment and that fire department members who engage in or are exposed to the hazards of wildland firefighting shall be provided with and use a protective ensemble that meets the requirements of NFPA 1977" (p. 1500-17). NFPA 1500 does not distinguish between structural and wildland fire services in establishing these standards (NFPA, 1997).

Budd, et al. (1996) suggests that while structural personal protective clothing and equipment have greatly reduced the number of firefighter deaths and injuries caused by burns, it may well be compounding the problem of deaths and injuries related to stress and heart attacks. For example, according to NFPA, 50.6% of all on duty firefighter deaths were caused by heart attacks and 34% were directly attributed to stress and over exertion. Burns accounted for only 7.8% of all firefighter deaths nationwide during the same year.

A review of firefighter fatalities on wildland fires indicates that structural firefighters have a greater risk of death by stress and/or heart attack than wildland firefighters. One hundred forty-seven firefighters died as a result of wildland fires during the period from 1978 through 1987. Of these, 111 were killed during suppression operations and 64 were members of the structural fire services. Heart attacks caused by stress and physical exertion accounted for more than half the deaths of these structural firefighters (NWCG, 1990).

The cost of wildland personal protective clothing is significantly lower than the cost of structural personal protective clothing. Depending on the manufacture, the cost of outfitting a structural fire fighter, not including a self contained breathing apparatus is approximately \$1000.00 while the cost to outfit a wildland firefighter, not including boots, is approximately \$300.00 (Winston, 1997).

PROCEDURES:

Sixty-three fire departments providing county wide fire protection in Florida were asked to complete a one page questionnaire regarding their departments involvement with wildland fire suppression operations and their department's use of wildland personal protective clothing and equipment during these activities.

The nine question survey addressed the demographics of each department, their involvement in wildland fire suppression operations and the type of personal protective clothing and equipment provided to their firefighters during these operations.

Information requested in the survey was used to determine if any structural fire departments in Florida are providing wildland personal protective clothing and equipment to firefighters who routinely engage in wildland-urban interface fire suppression. Each item in the survey was designed to obtain specific information which is described as follows:

Item 1. This item was used to determine the size of the department being surveyed.

Item 2. This item was designed to determine the ratio of career versus volunteer firefighters within the department.

Item 3. This item was used to determine if the department routinely responded to wildland-urban interface fires.

Item 4. The purpose of this question was to determine the number of wildland-interface fires the department responded to annually.

Item 5. The purpose of this question was to determine the percentage of wildlands and/or interface areas within the departments jurisdictional area.

Item 6. This item was used to determine if departments had existing standard operating procedures for wildland fire suppression operations.

Item 7. This item was used to determine if the department provides wildland personal protective clothing and equipment to its firefighters who regularly respond to wildland fires.

Item 8. The purpose of this item was to determine which types of wildland personal protective clothing and equipment is provided to the department's firefighters.

Item 9. This item was used to determine reasons for not providing wildland personal protective clothing and equipment to firefighters.

It is assumed that knowledgeable and responsible individuals answered the survey and did so honestly. Three weeks were allowed for returning the survey. No calculations were made to determine the margin of error in the survey results.

RESULTS:

Of the sixty-three surveys mailed, 46 (73%) were completed and returned by the March 12, 1999 deadline. Five surveys were returned after the deadline and were not included in tabulating the results. Response to the surveys are summarized as follows.

In Question One, eleven (24%) departments reported having less than 25 members. Twelve (26%) departments had 26-50 members and six (13%) departments reported having 51-100 members. Four (9%) departments had 151-200 members and seven (15%) reported having 201-500 members. Four (9%) departments reported having greater than 500 members.

In Question Two, seventeen (37%) departments reported being paid or career departments and seven (15%) reports being volunteer. Twenty-three (50%) departments reported their makeup as varying combinations of career and volunteer personnel.

Thirty-six (78%) responding departments stated in Question Three that they routinely engaged in wildland fire suppression activities while ten (22%) stated they were not routinely involved with wildland fire.

In Question Four, the number of wildland fires responded to annually were as follows: Two (4%) departments stated that they did not respond to wildland fires. Sixteen (35%) reported that they responded to 1 to 25 wildland fires annually, seven (15%) departments responded to 26 to 50 fires and two (4%) departments responded to 51-75 wildfires annually. Two (4%) departments reported responding to 76-100 wildfires annually and sixteen (35%) departments reported responding to greater than 100 wild fires on an annual basis.

In Question Five, the percentage of rural or wildland interface within each department's jurisdiction were as follows: Five (11%) departments reported having no wildland interface within their district. Six (13%) departments reported having 1-20 percent of their coverage area as being wildland-urban interface, six (13%) departments reported having 21-40 percent wildland-urban interface and seven (15%) departments reported having 41-60 percent wildland-urban interface within their coverage area. Fourteen (30%) departments stated that 61-80 percent on their fire districts were considered wildland-urban interface and four (9%) departments reported that 81-100 percent of their area was considered wildland-urban interface.

In Question Six, twenty-six (56%) departments stated that they had written standard operating procedures for wildland fire suppression operations and that these procedures included standards for wildland personal protective clothing and equipment. Twenty-one (44%) reporting departments did not have such standard operating procedures.

Twenty-five (54%) departments reported in Question Seven that they provided wildland personal protective clothing and equipment to their personnel who regularly respond to wildland fires. Twenty-two (46%) stated that they did not provide this clothing and equipment.

In Question Eight, nine (19%) departments stated that they provided fire shelters, 20 (43%) reported providing hardhats, 12 (26%) provided leather boots and 21 (46%) provided leather gloves. In addition, 6 (13%) departments provided Nomex jump suits and 19 (41%) provided a Nomex shirt and pants combination. Two (4%) departments stated that they provided Nomex shirts only. Only four (9%) departments reported providing full complements. Seventeen (37%) departments reported that they do not provide wildland personal protective clothing and equipment. A summary of protective clothing and equipment provided is shown in Table 1.

Twelve (26%) departments responding to Question Nine stated that cost was the primary reason for not providing wildland personal protective clothing and equipment to their firefighters. Six (13%) departments stated that frequency of wildland fires kept them from providing this clothing and equipment. The remaining departments did not answer the question.

Table 1
Distribution of Wildland Personal Protective Clothing and Equipment

Clothing and Equipment	No. of Departments Providing	Percentage
Fire Shelter	9	19%
Nomex Shirts and Pants	19	41%
Nomex Jumpsuits	6	13%
Hardhats	20	43%
Leather Boots	12	26%
Leather Gloves	21	46%
Wildland Gear Not Provided	22	49%
Full Complements	4	9%

DISCUSSION:

One observation that the survey raises is the relationship between Question Three, departments responding to wildland fires on a regular basis, and Question Four, the number of fires actually responded to. Just what is considered routine? Eighteen departments that reported responding to wildland fires on a regular basis are responding to less than 25 wildland fires annually. Does this low number of fires justify purchasing wildland personal protective clothing and equipment? Information gained from the literature review suggests this is not necessary. The author concurs.

However, at the other end of this spectrum, eighteen departments are responding to greater than 76 wildland fires each year. Of these, fifteen are responding to greater than 100 wildland fires annually. Fifty percent of these departments are not providing wildland personal protective clothing and equipment to their personnel and fifty percent are providing some combination of this clothing and equipment. Departments responding to these numbers of fires without providing wildland personal protective clothing and equipment have greater opportunities for injuries to firefighters. One would believe that the odds of experiencing a wildland related injury or fatality will eventually catch up with these departments.

The survey showed that there is a direct correlation between fire occurrence and the percentage of wildland-urban interface within a fire department's response area. In other words, the greater the area of wildland-urban interface the greater the number of fires (and the greater the need for wildland personal protective clothing and equipment). However, some departments that reported having greater than 60% wildland-urban interface have relatively low fire occurrences.

More than half of those were providing wildland personal protective clothing and equipment. The point is that fire departments must also consider the potential for wildland fires when considering whether or not to provide this equipment. A high potential for wildland fire occurrence may be justification enough for providing it.

A special concern noted from the results is that only 19% of the departments responding to the survey were providing fire shelters to personnel who regularly respond to wildland fires. Only three departments responding to greater than 76 wildfires annually were providing fire shelters. This is noteworthy since the literature review identifies the fire shelter as the most important piece of personal protective equipment that firefighters can carry while suppressing wildland fires.

It is believed that departments responded to the survey honestly, however there is concern that some departments assume that some structural personal protective gear provides the same protection as wildland gear and therefore is an adequate substitute. In numerous cases, responding departments stated that they provided wildland protective clothing but listed only such items as eye protection, hardhats and leather gloves. They were not providing Nomex fire shirts and pants. The literature review points out that wildland and structural protective clothing and equipment are not interchangeable.

An interesting observation is the number of departments who issue wildland personal protective clothing and equipment without having standard operating procedures for when it will and will not be used. The survey numbers (6 of 21 departments) are not significant however, they do raise a concern that the decision of when to use this equipment is being left up to the firefighter. The conditions under which wildland personal protective clothing and equipment are

to be used, should be clearly spelled out as department policy. Leaving this decision up to the firefighter creates opportunities for injuries, fatalities and lawsuits. Fire departments issuing wildland personal protective clothing and equipment do, as a rule, have written standard operating procedures that cover the use of this gear.

National standards for wildland personal protective clothing and equipment noted in the literature review should raise liability concerns for structural departments that are not providing this equipment. In today's litigious society, a competent trial lawyer could make a good case against any department experiencing a firefighter injury or fatality where wildland personal protective clothing or equipment was not provided. The cost of providing this equipment is certainly cheaper than the cost of such a lawsuit. Twelve departments stated that cost was the primary reason for not providing this clothing and equipment. However, when looking at it from the liability perspective, one would think fire departments cannot afford not to provide this equipment.

RECOMMENDATIONS:

The survey for this research was intended primarily for fire departments providing county wide fire protection. These are more likely to be involved in wildland- urban interface fire suppression. However, that does not mean other, more urbanized departments do not participate in suppressing these kinds of fires. Wildland-urban interface fires occur in all Florida counties. Additional fire departments should be surveyed in order to gain a truer picture of structural fire departments use of wildland personal protective clothing and equipment on wildland-urban interface fires.

It would be unreasonable to expect (or require) fire departments responding to less than twenty-five wildland-interface fires annually to provide it's members with full complements of wildland protective gear. The same would be true for departments with smaller wildland-urban interface areas. However, departments with more frequent fire occurrence and larger wildland- urban interface areas should be providing this safety clothing and equipment. It is recommended that fire departments responding to greater than 25 wildfires per year and those with greater than fifty percent of their coverage area being considered wildland-urban interface provide wildland clothing and equipment to it's fire suppression personnel.

Fire departments who provide wildland personal protective clothing and equipment to their personnel without written standard operating procedures essentially allow their members to decide when and how to wear protective clothing. This defeats the purpose of having this gear. It is recommended that fire departments providing wildland personal protective clothing and equipment develop and enforce clearly written standard operating procedures for their use.

It is further recommended that fire departments issuing wildland personal protective clothing and equipment provide full complements of equipment (including fire shelters) that meets national standards stated in NFPA 1977. Failure to do so may subject the department to law suits resulting from failure to provide this clothing and equipment.

BIBLIOGRAPHY:

Budd, G., Brotherhood, J., Hendrie, L., Cheney, P., Dawson, M. (1996 July). Safe and protective brushfire fighting with hand tools. Australian Government Publishing Service.

Bone, B.G., Clark, D.F., Smith, D.L., Ptruzzello, S.J. (1994 November). Physiological responses to working in bunker gear; a comparative study. Fire Engineering, 52-55.

Grilliot, M.I., (1989 January February March). Developing minimally stressful protective clothing. Chief Fire Executive, 32-34.

Mangan, R.J., (1993 October-November). Protective clothing and equipment: an important first line defense for wildland firefighters. Firefighter's News, 28-30.

Mangan, R.J., (1998 November). Improving firefighter safety on 21st century wildfires. Symposium conducted at the 3rd International Conference on Forest fire Research, Luso, Portugal.

Mangan, R.J., (1996 August). Wildfire safety, equipment, training, and attitudes. Seminar on Forest, Fire, and Global Change, Sushenskoye, Russian Federation.

Mangan R.J., (1997 November). Firefighter safety in the wildland-urban intermix. Paper presented at the symposium on Fire in California Ecosystems: Integrating Ecology, Prevention and Management, San Diego, CA.

National Fire Protection Association. (1997). Fire department occupational safety and health program. NFPA 1500. Quincy MA.

National Fire Protection Association. (1998). Standard on protective clothing and equipment for wildland firefighting. NFPA 1977. Quincy MA.

National Wildfire Coordinating Group. (1990). Fire fighter safety in the wildland-urban interface. NFES Publication No. 2102 Boise ID.

University of California at Davis. (1998). Protective clothing for wildland firefighters. Author.

U.S. Forest Service. (1986). Your fire shelter [film]. (Available from U.S. Forest Service Equipment Development Center., Missoula, Montana).

Winston, R.M., (1997 July). Structural wildland interzone: let's lighten up. Firehouse Magazine, 142-150.

APPENDIX A

SURVEY QUESTIONS:

1. What is the size of your department?
 <25 26-50 50-100 101-150 151-200 201-500 500+
2. What is the makeup of your Department?
 Paid_____ Volunteer_____ Combination (please list by percentage)
3. Does your department routinely engage in wildland fire suppression?
 Yes_____ No
4. Typically, how many wildland fires does your department respond to annually?
 None 1-25 26-50 51-75 76-100 100+
5. What percentage of your area is considered rural or wildland- interface?
 None 1-20 21-40 41-60 61-80 81-100
6. Does your department have standard operating procedures for wildland fire suppression including standards for personal protective equipment.?
 Yes_____ No
7. Does your department provide wildland personal protective equipment to personnel who regularly respond to wildland fires?
 Yes_____ No
8. If yes, please check which wildland PPE components are provided.
 Fire Shelter_____ Hard Hat_____ Leather Boots
 Leather Gloves_____ Eye Protection_____ Nomex Jumpsuits
 Nomex Shirt and Pants_____ Wildland PPE Not Provided
9. If no, then what are the primary reasons for not providing wildland PPE?